How to Visualize Success:

Presenting Complex Data in a Writing Strategy Tutor

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ABSTRACT

Intelligent tutoring systems (ITSs) have been successful at improving students' performance across a variety of domains. To help achieve this widespread success, researchers have identified important behavioral and performance measures that can be used to guide instruction and feedback. Most systems, however, do not present these measures to the teachers who employ the systems in classrooms. The current paper discusses visualizations that will be displayed to teachers using the writing strategy tutor, Writing Pal. We present visualizations for both classroom and student level data and offer descriptions of each.

Keywords

Visualizations, intelligent tutoring systems, writing instruction.

1. INTRODUCTION

Over the past several decades, intelligent tutoring systems (ITSs) have been successfully developed for and implemented across a variety of domains [1]. These computer-based systems are often designed to record every interaction, behavior, and performance marker a student achieves while using the system. Research in educational data mining has used these system logs to identify what data are most predictive of overall performance and learning [2], while research in the learning sciences has used system logs to tailor instruction to individual students [3]. The synthesis of this work yields more adaptive, effective systems.

The analysis of log data has helped develop complex computational algorithms that improve adaptability within ITSs by modeling the learner [4]. Learner models can be difficult to understand without experience in modeling and educational research, and as a result, researchers have developed visualization tools to render components of these models more accessible [5]. Such tools are important because of the potential disadvantages that may emerge when the teachers who use ITSs have little understanding of their underpinnings. For instance, teachers may be less likely to use a system if they do not understand a system's feedback or what drives the feedback [6]. Moreover, if a system does not convey appropriate and timely information about students, the instructor may be unable to intervene [7].

Visualizations provide one means of aiding teachers in deciphering the complexity of ITSs and making data-driven classroom decisions [e.g., 8]. Our team is working toward providing visualizations of student progress within the Writing Pal (W-Pal), a writing strategy ITS designed for high school students. Writing Pal provides strategy instruction via lesson videos, game-based strategy practice, and essay practice with automated, formative feedback [9]. In this paper, we describe visualizations we have developed and implemented as well as those we are currently prototyping.

2. VISUALIZING DATA

Our initial goal is to provide the most relevant and understandable data to teachers through intuitive visualizations. The following sections describe visualizations that we are developing for W-Pal's *teacher interface*, where teachers view students' progress.

2.1 Classroom Level Visualizations

In a recent classroom implementation of W-Pal, five ninth grade classes with the same teacher used the system for approximately four months. We analyzed data from 90 consenting students. For the study, W-Pal's teacher interface included a spreadsheet in which teachers could track students' progress through the system activities (see Figure 1). However, during the study, this page did not provide a visual summary of the progress across students. Broadcasting the average number of activities attempted in a classroom of students who have generally stalled in their progression might prompt teachers to request that students not linger on particular topics or switch their focus. Future iterations of W-Pal will provide easily discernible bars that indicate the overall progress of classes. In Figure 1, the darker blue bars in the first four columns represent the percentage of activities attempted for those modules (a black rectangle highlights this feature).

Figure 1. Visualization of a classroom's progress in W-Pal's teacher interface; dark blue bars represent progress.

An important strength of W-Pal is the automated feedback it provides on students' essays. The teacher interface allows teachers to view each student's submitted essays along with the feedback and score received. Currently, however, teachers do not have access to a summary of all students' performance. For example, if the majority of students are struggling to properly structure their writing in W-Pal, teachers would remain unaware until they carefully perused students' feedback messages. To provide teachers with a quickly consumable summary of the feedback that students are receiving, we are developing a visualization that displays the percentage of feedback triggered across all essays in a W-Pal class (see Figure 2). Using this information, teachers might adjust their own classroom instruction or assign students to interact with appropriate W-Pal lessons.

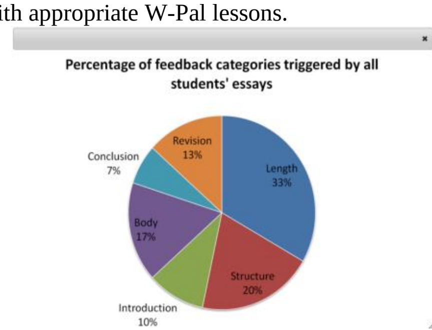

Figure 2. Visualization of the type of essay feedback students in a classroom have received.

2.2 Student Level Visualizations

Our recent classroom study also revealed that the percentage of time that students selected different activities related to their persistence in the system. For example, there was a positive correlation between the percentage of *game* activities that students selected and the number of days they used the system [$r(90) = .49$, $p < .001$]. Thus, the percentage of activities attempted (i.e., videos, games, and essay practice) could be indicative of how likely students are to persist in the system. Teachers will be presented with this information via pie charts, which are useful for visualizing proportions of a whole [10] (see Figure 3).

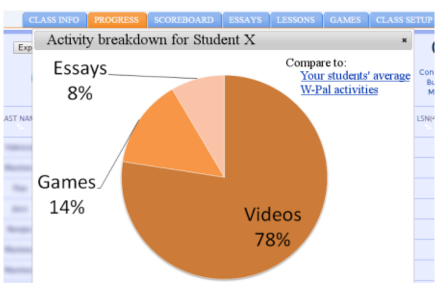

Figure 3. Visualization of the activity breakdown for an individual student.

Similar to the activity breakdown available for each student, teachers will be able click students' names in the essay window to see breakdowns of essay feedback (see Figure 2 for a similar example). If a student is struggling with writing assignments in class, this visualization will give teachers a quick view of how W-Pal has assessed areas of weakness.

3. CONCLUSION

In this paper, we argue for the importance of using visualizations to communicate data from ITSs to the teachers. Specifically, we describe classroom and student level visualizations that we are developing for the writing strategy tutor, W-Pal. When equipped with these visualizations, teachers may be more likely to use a system appropriately and to intervene when a student is not performing optimally. Future empirical work must test these visualizations, through techniques ranging from surveys to eye tracking [8], to determine their effectiveness in conveying information to teachers. As the understanding of how teachers use such visualizations grows, systems can provide teachers with intelligent tutors that better support classroom instruction.

4. ACKNOWLEDGMENTS

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